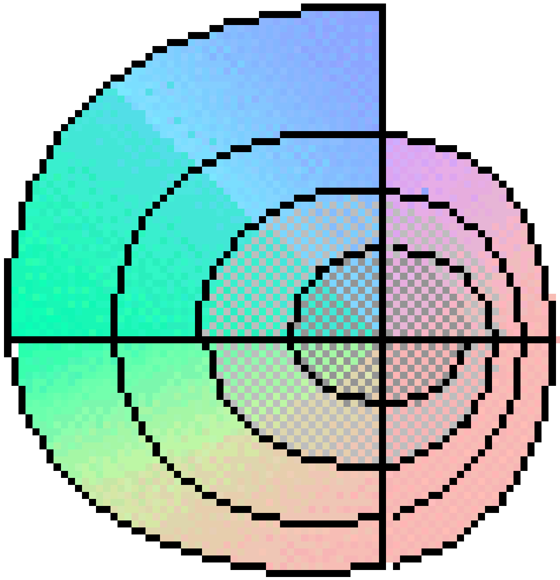
Evolutionary Acquisition and Spiral Development Workshop



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Workshop Outline

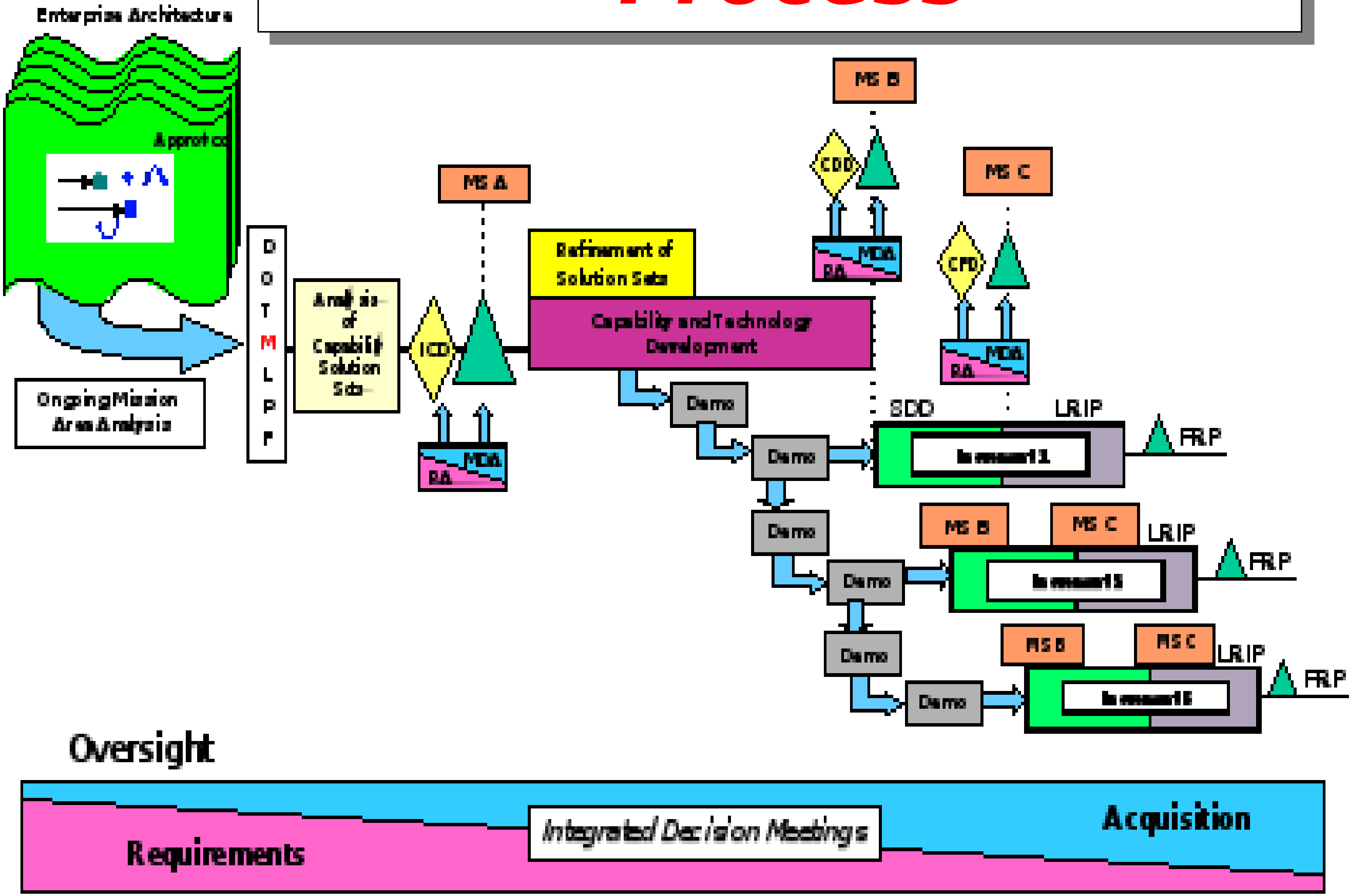
- Background and Definitions
- User Issues
- Technical Challenges
- Cost Challenges
- Acquisition Community Support
- JRATS Development Problem

Evolutionary Acquisition

Evolutionary acquisition is DoD's preferred strategy for rapid acquisition of mature technology for the user. An evolutionary approach delivers capability in increments, recognizing, up front, the need for future capability improvements. The success of the strategy depends on the consistent and continuous definition of requirements and the maturation of technologies that lead to disciplined development and production of systems that provide increasing capability towards a materiel concept.

RAFT *Attachment 2 to SecDef Memo,* Ops of the Defense Acquisition System**, wJS***, September 18, 2002*

Requirements/Acquisition Process



Evolutionary Acquisition Characteristics

- General description of desired full system functional capability

- Concise statement of full system operational concepts

- Flexible overall architecture allowing incremental design
    - Use of Open Systems Architecture is one method

- Plan to incrementally achieve desired total capability

- Early definition, funding, development, testing, supporting and operational evaluation of initial increment of operational capability

- Continual dialogue and feedback among users, developers,

Relationship of EA to SD and ID

- Evolutionary Acquisition is an *acquisition strategy*
- Spiral Development and Incremental Development are *development processes* or *methodologies* in which a product is developed and acquired in increments vice the complete system.
  - Which process is used depends on whether the requirements are known up front.

Spiral Development

- Spiral Development (SD) definition
  - In this process, a desired capability is identified, but **the end-state requirements are not known at program initiation**. Those requirements are refined through demonstration and risk management; there is continuous user feedback; and each increment provides the user the best possible capability. The requirements for future increments depend on feedback from users and technology maturation. .

[Emphasis added]

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Incremental Development

- Incremental Development (ID) definition
  - In this process, a desired capability is identified, **an end-state requirement is known**, and that requirement is met over time by development of several increments, each dependent on available mature technology.

[Emphasis added]

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Spiral Development Background

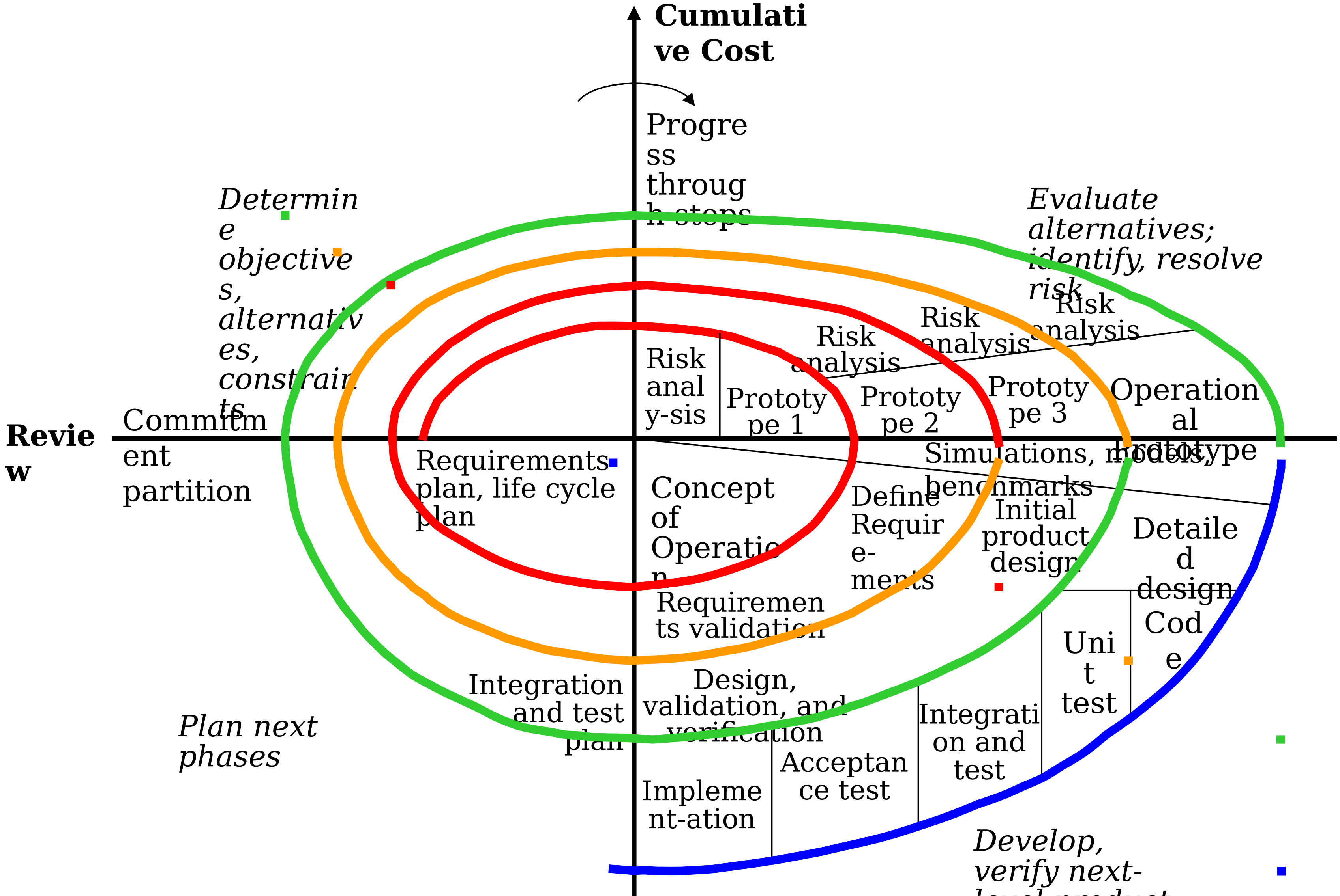
- First articulated by Barry Boehm in1988
  - Generally accepted, recently refined:

“The Spiral Development Model is a **risk-driven** process model generator for guiding **multi-stakeholder** concurrent engineering of software-intensive systems. Its distinguishing features include a **cyclic approach** for **incrementally** growing a system’s degree of definition and implementation, and a set of **anchor point** milestones for ensuring feasibility of the incremental definitions and implementations”--Boehm, *“Spiral Development - Experience and Implementation Challenges”*, CMU/SEI-2000-SR-006 February 9-11, 2000, Page 9.

[Emphasis added]

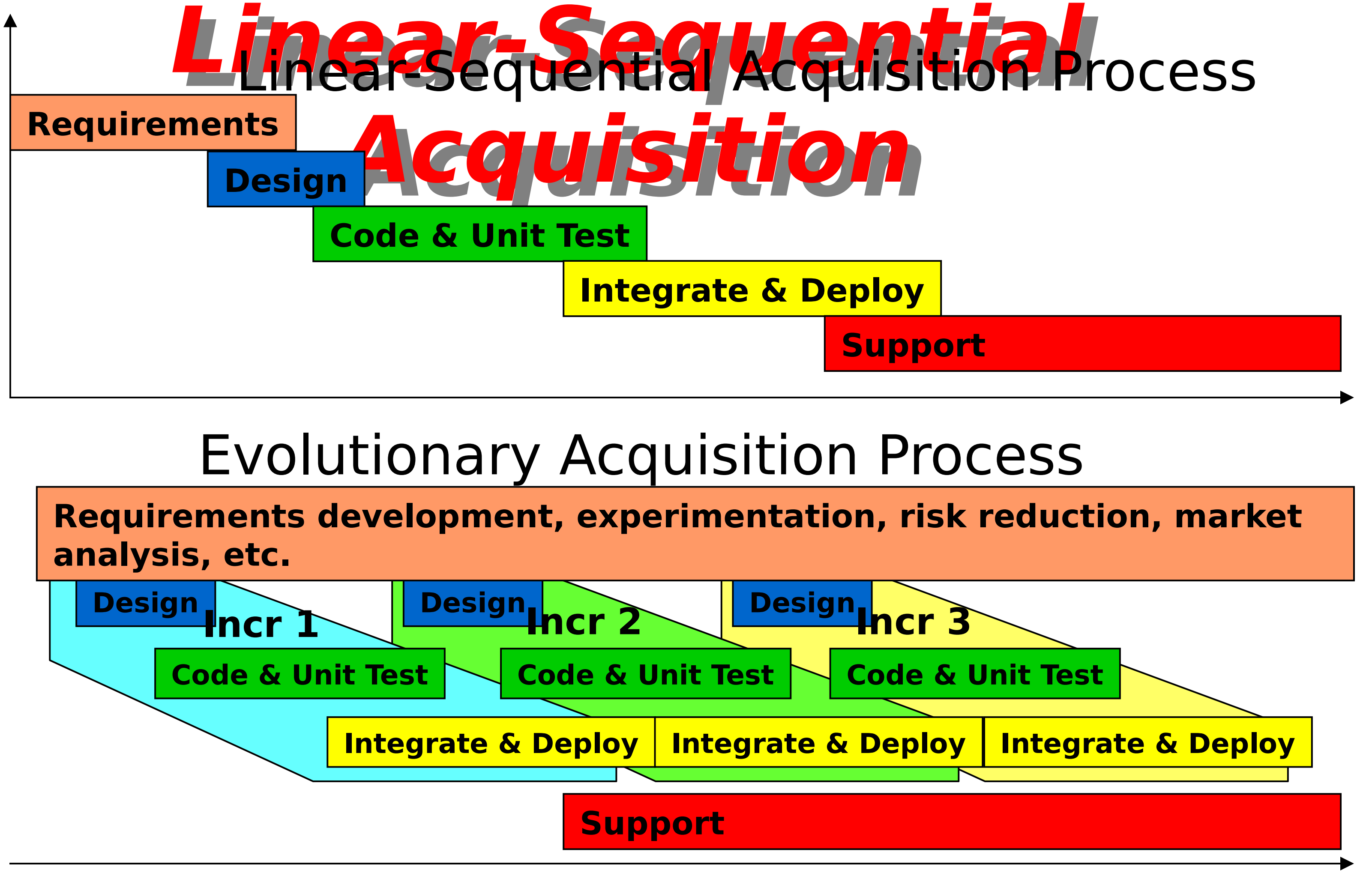
  - Spiral Development came out of the software community as a response to the high number of large software development failures

Spiral Development Model*



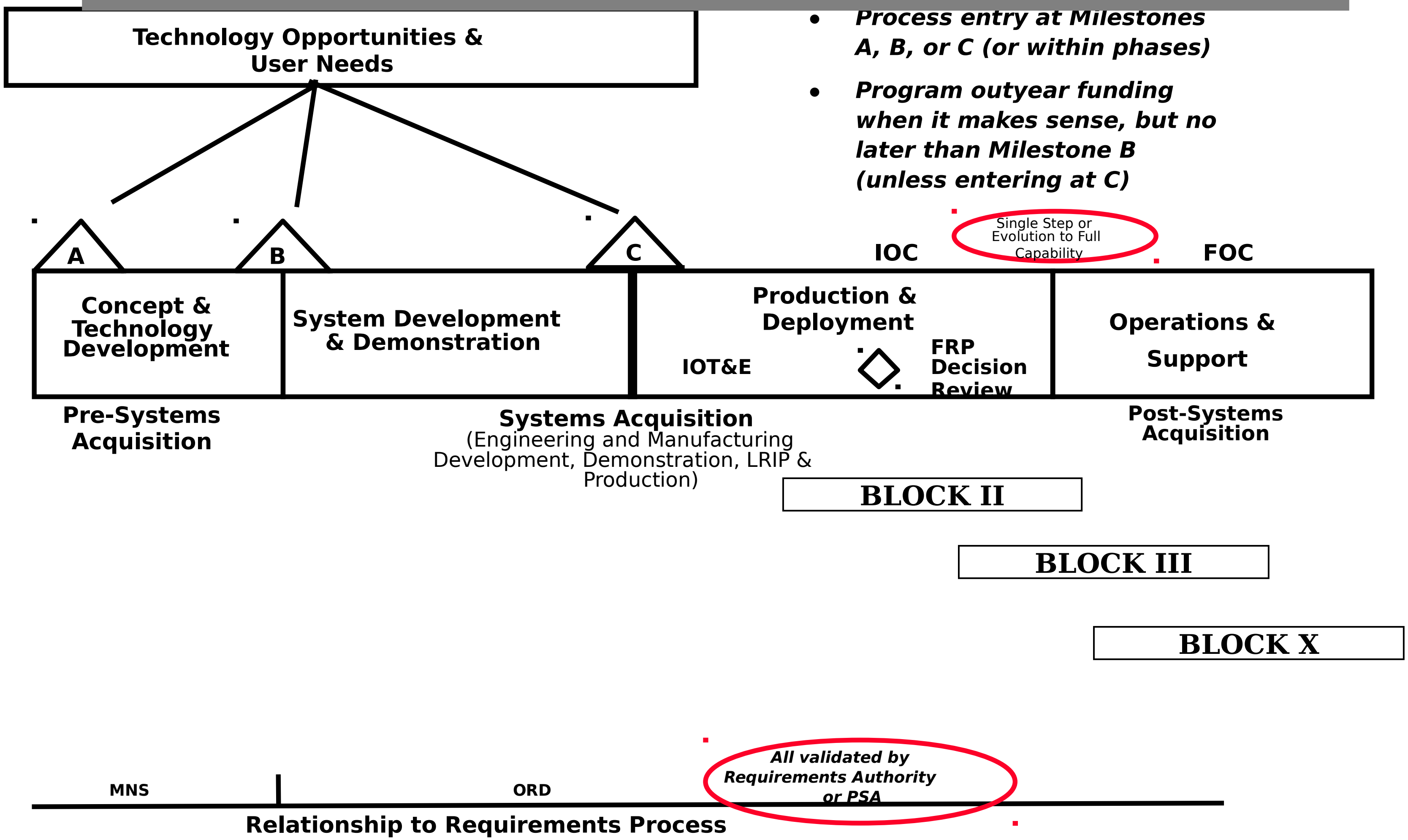
*Reference: "The Spiral Model as a Tool for Evolutionary Acquisition" Crosstalk -The Journal of Defense Software Engineering, May 2001; Dr. Barry Boehm

Evolutionary Acquisition versus Linear-Sequential Acquisition



The DoD 5000 Model

- ***Process entry at Milestones A, B, or C (or within phases)***
- ***Program outyear funding when it makes sense, but no later than Milestone B (unless entering at C)***



User Issues

- Acquisition Community must prove they can deliver under this new process
  - Must deliver what is agreed to when it is agreed to
- In the past, people and resources fall dramatically when a system meets IOC
  - Under an evolutionary approach, up to 40% of the capability may still be in some stage of development
  - Follow-on blocks must receive the same priority and commitment as the first

Past Performance

- Evolutionary acquisitions have not had a good past history
  - F-14 Tomcat IOC in mid 1970s
    - Deployed with the TF-30 engine as an “interim” solution due to F-100 engine development problems
    - Successfully deployed the AWG-9 weapon system for fleet defense
    - Numerous engine related accidents
    - Began replacement of TF-30 with F-110 in the late 1980s
    - It took about 25 years to replace the “interim” solution

User Involvement

Acquisition Policy $\neq$ User Buy In

Full user support and involvement is necessary for a suc
spiral development effort.
We must do a better job if we expect user support.

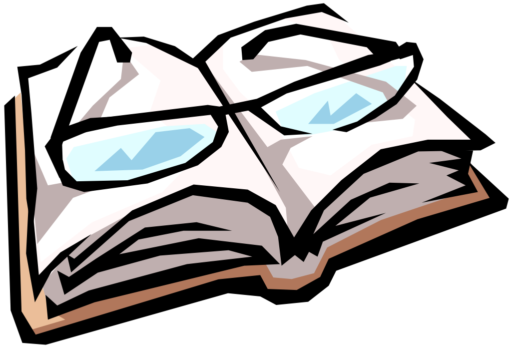
Technical Challenges

- Spiral Development requires a solid systems engineering process for success
  - Requirements Development
  - Trade Studies
  - Risk Management
  - Configuration Management
  - Architecture Development
  - Interface Management
- Product must be designed from the start for upgrade and technology insertion

Design for Product Evolution

- Plan From The Beginning
- Focus: Make It Easy To Modify
- Standard Interfaces
  - Compartmentalized Design
  - Modularity
  - Recognized Interface Standards (preferably commercial)
- Standard Components
  - Increases opportunities for COTS, NDI
- Emphasize Interface Control To Provide Inherent Upgrade Capability

Definition of Open Systems



"…An open systems strategy focuses on fielding superior warfighting capability more quickly and more affordably by using

- multiple suppliers, and
- commercially supported practices, products, specifications, and standards

selected based on performance, cost, industry acceptance, long term availability and supportability, and upgrade potential."

DOD 5000.2-R

Attributes of an Open System

- Standards are Commonly Available
- Multiple Sources of Supply
  - Acquire building blocks from several sources on continuing basis
  - DoD is one of many customers for these building blocks
- Technology Transparency
  - Replace building blocks (HW or SW) without redesign
  - Incorporate new technology as it comes to market
- Lower life cycle cost for weapon systems
- Better performing systems with

But what about Special Military Requirements?

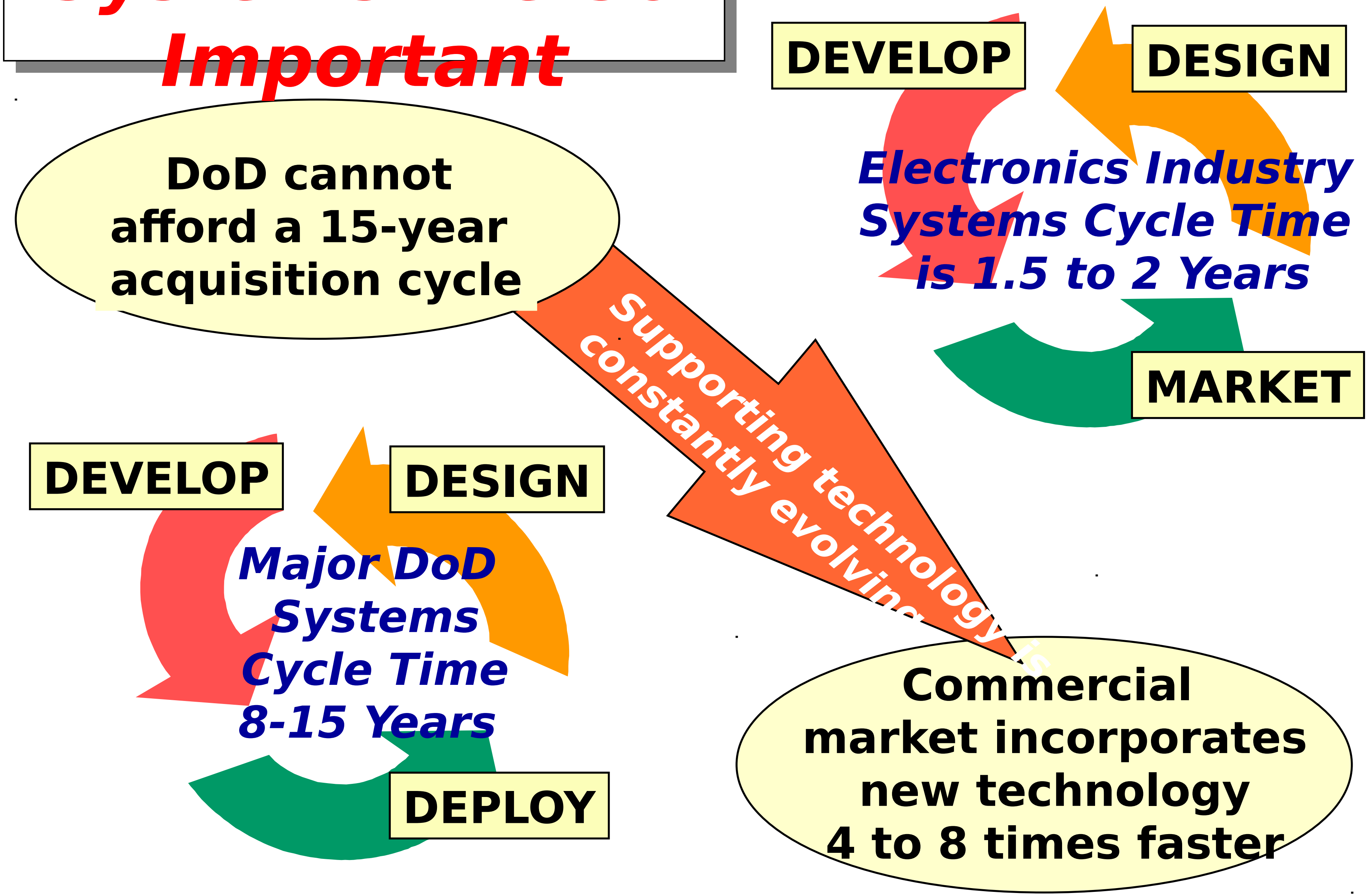
- Specification of requirements in performanced-based language
  - Tell contractors what you need, not what to build
- Commercial items can be integrated into military systems by designing protection around the item

Radar Displays

Old display
welded to deck
Monochromatic
Big and heavy

Commercial Display
Color picture
Rack mounted
Unit protection in shock
mounts

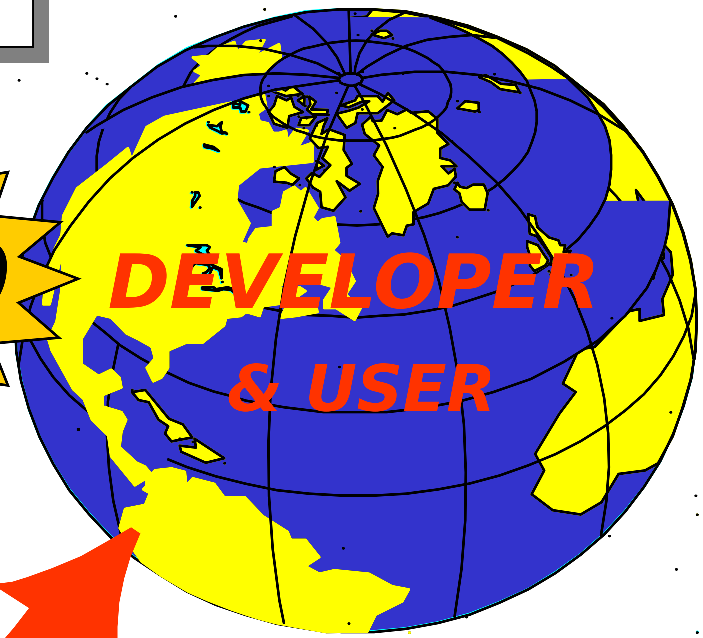
Why Open Systems Are So Important



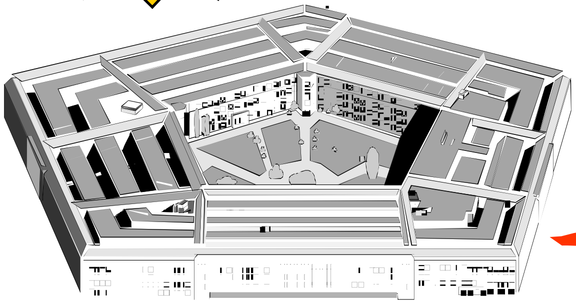
Why Open Systems Are So Important

1950

2000



DEVELOPER & USER



DEVELOPE R

& USER

DOD no longer “drives” development. Instead, it mus what industry has developed for commercial applications.

2002 First Responders Business Acquisition Wargame

- Sponsored by Office of Naval Research
- Crisis response to terrorist attack
  - Requirements for rescue and strike missions
  - Participants brought robotic vehicles which required technology insertion, modification and integration to perform cooperative tasks to complete the missions
  - Only three hours to do the work

Wargame Results

- Those systems which used commercial standards and parts were readily integrated and successfully completed both missions
  - One vehicle was built by one university but added in the control system and software developed by another school.
- Those systems which used proprietary or non-standard components were unable to participate in cooperative missions.

Open Systems in Systems Engineering

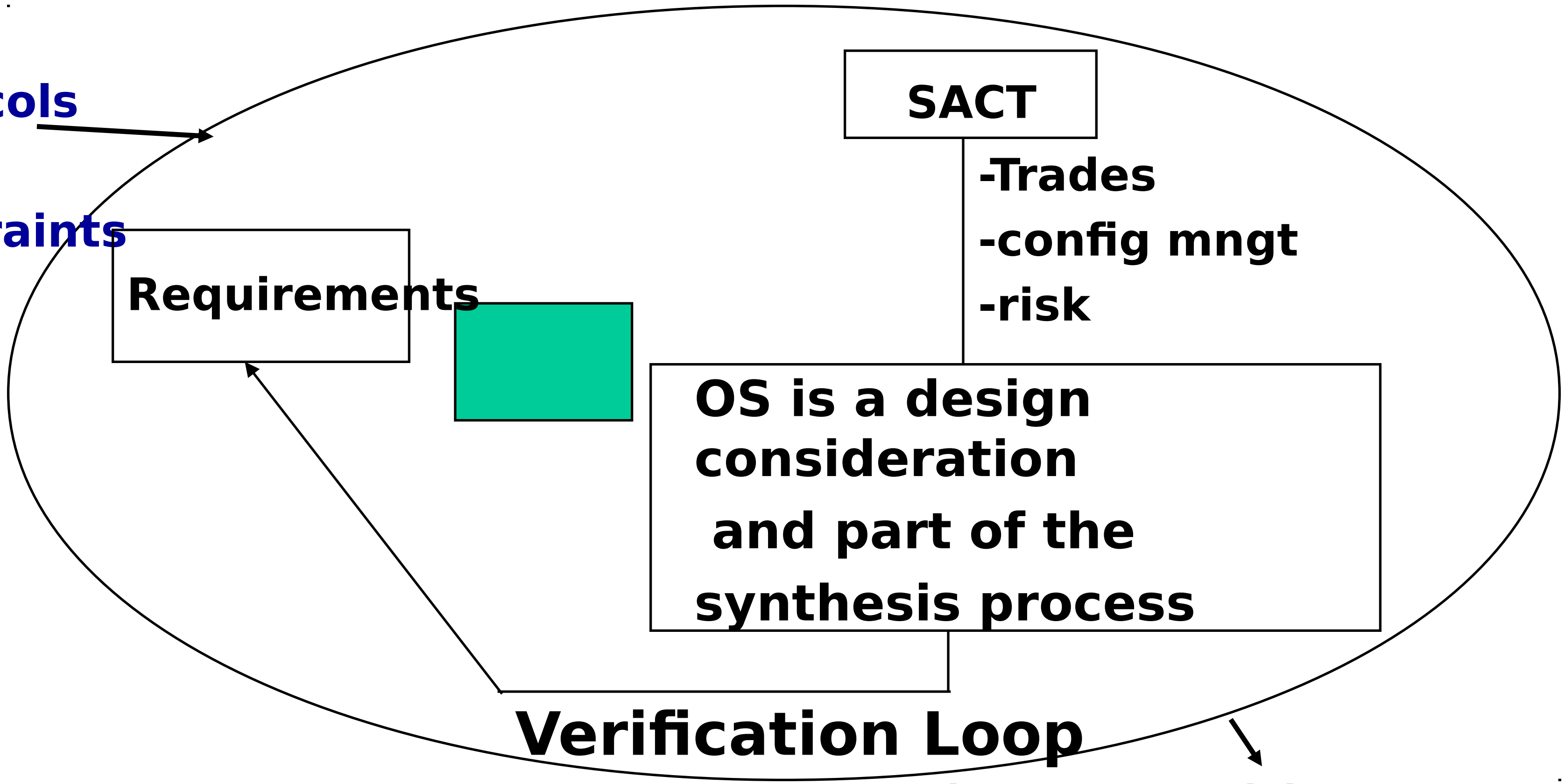
OS consideration is an SE input

Stds

protocols

JTA

constraints



OS is an output of the SE process in the form of the system architecture

Technology Transition Program Manager's Perspective

- How mature is the technolo
- What are the risks?
- What are the payoffs?
- Cost and schedule?
- Where to enter the acquisition cycle?

Technology Readiness Levels 1-3

Technology Readiness Level	**Description**
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into **applied research and development. Examples might include paper studies of a technology's basic properties.**
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. **Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.**
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements

Technology Readiness Levels 4-6

4. Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples

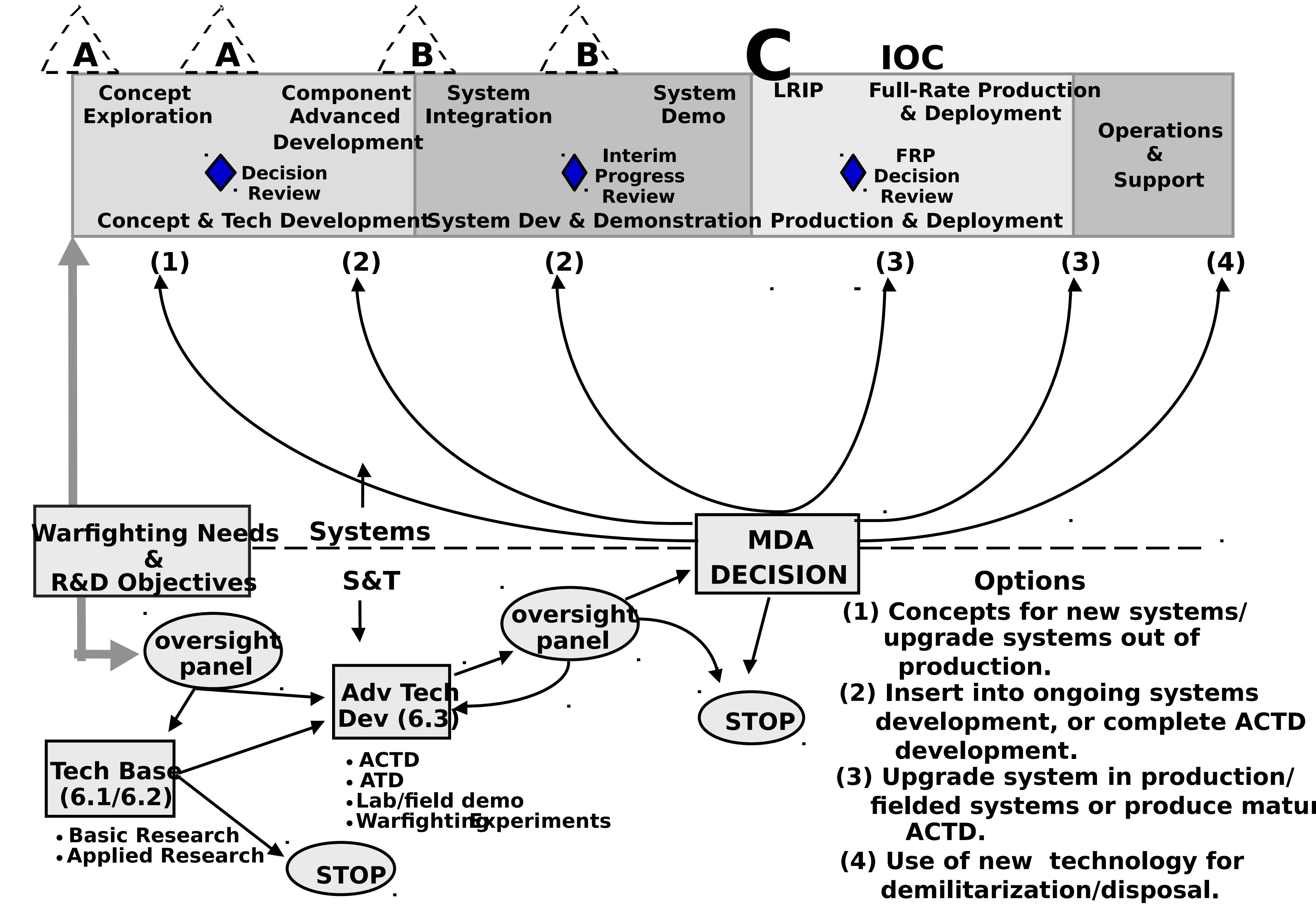
Technology Readiness Levels 7-9

7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment **such as an aircraft, vehicle, or space.** Examples include testing the prototype in a test bed aircraft.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those

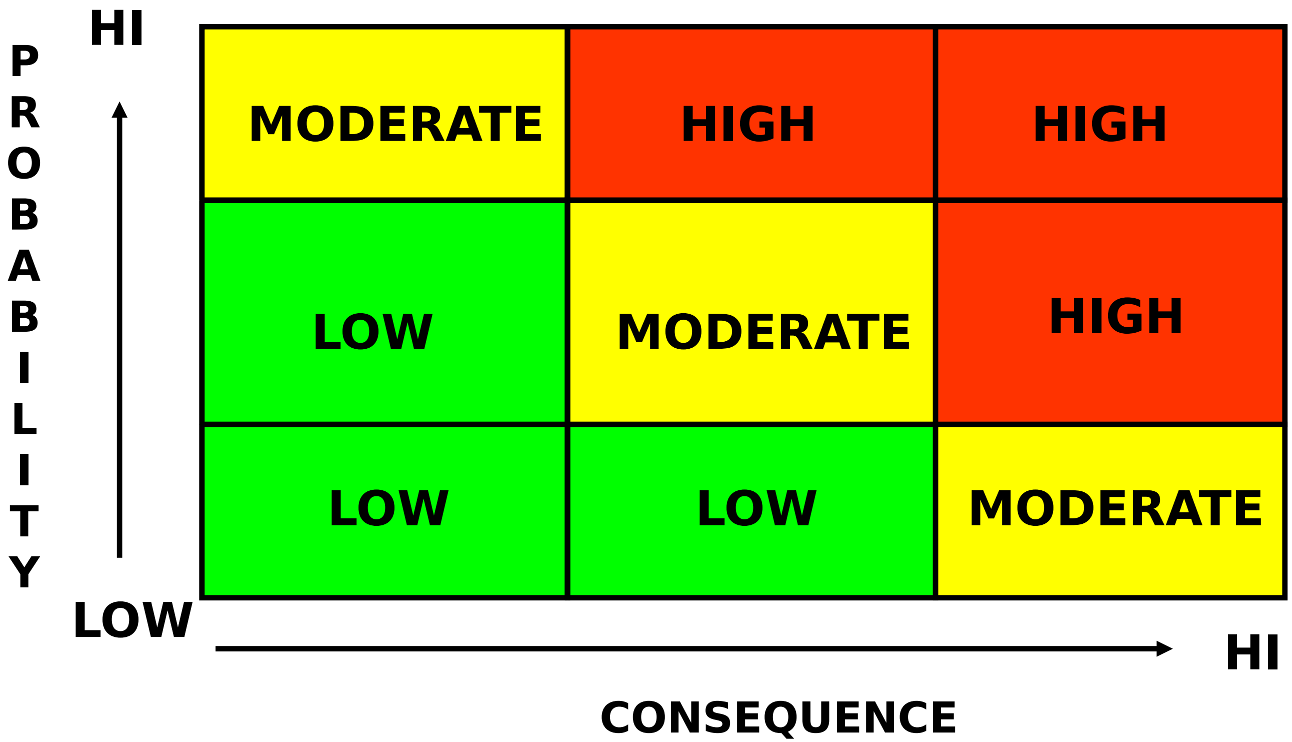
Technology Insertion

Research (TRL 1) Technology (TRL 2)	Remain in S&T or Concept Explora
Proof of concept (TRL 3) Components validated in lab (TRL 4)	Component Advanced Development
Components validated in relevant environment (TRL 5)	System Integration
System/subsystem model demonstrated in relevant environment (TRL 6)	System Demonstration
System prototype demonstrated in an operational environment (TRL 7)	Milestone C

&T Linkage to Defense Acquisition Proce



Determining Technology Risk

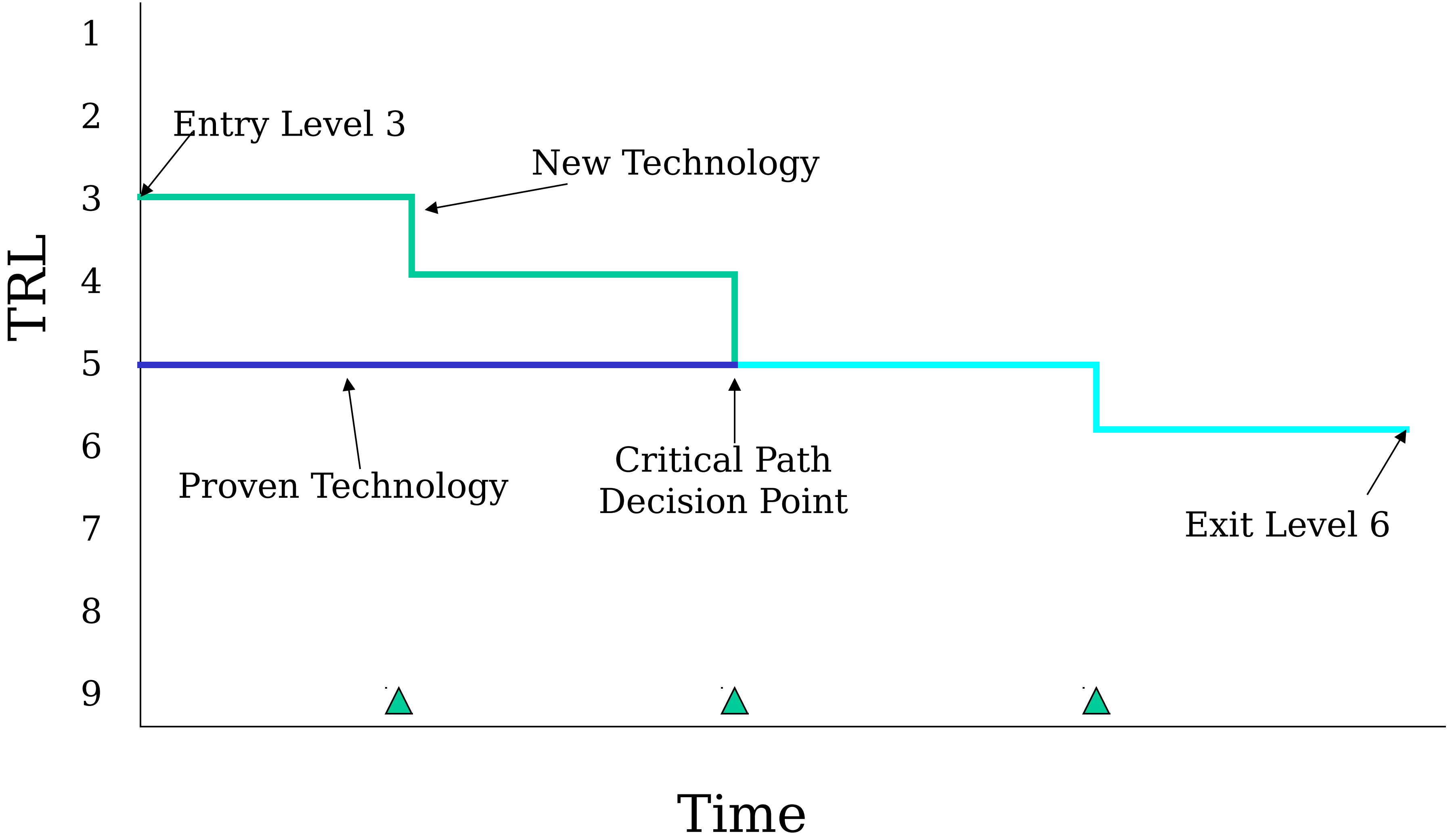


Technology risk is a function of the probability that a t
will not deliver its expected benefit and the consequen
system of not achieving that benefit

Risk Mitigation

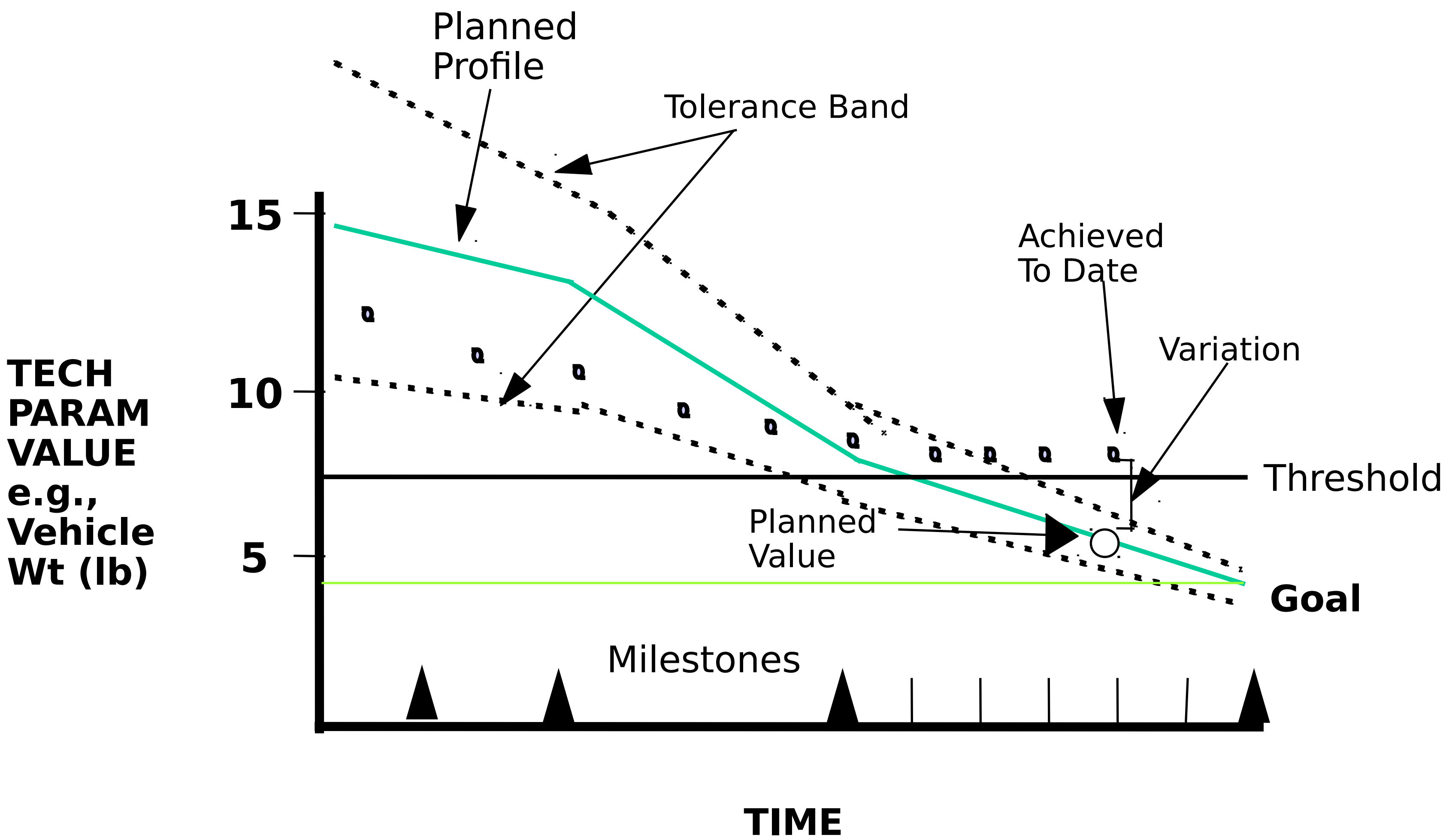
- Can Take Many Forms
  - Budget Reserves for unplanned activities
  - Concurrent Design Techniques
  - Solid technical management (TPMs, EVM, CM, Tech Reviews, etc.)
  - Integrated Tools, Automated Tools
  - Balanced Designs - Cost, performance, supportability, producibility trades
  - Disciplined Systems Engineering application
  - Bottoms Up Testing

Technology Risk Reduction Plan

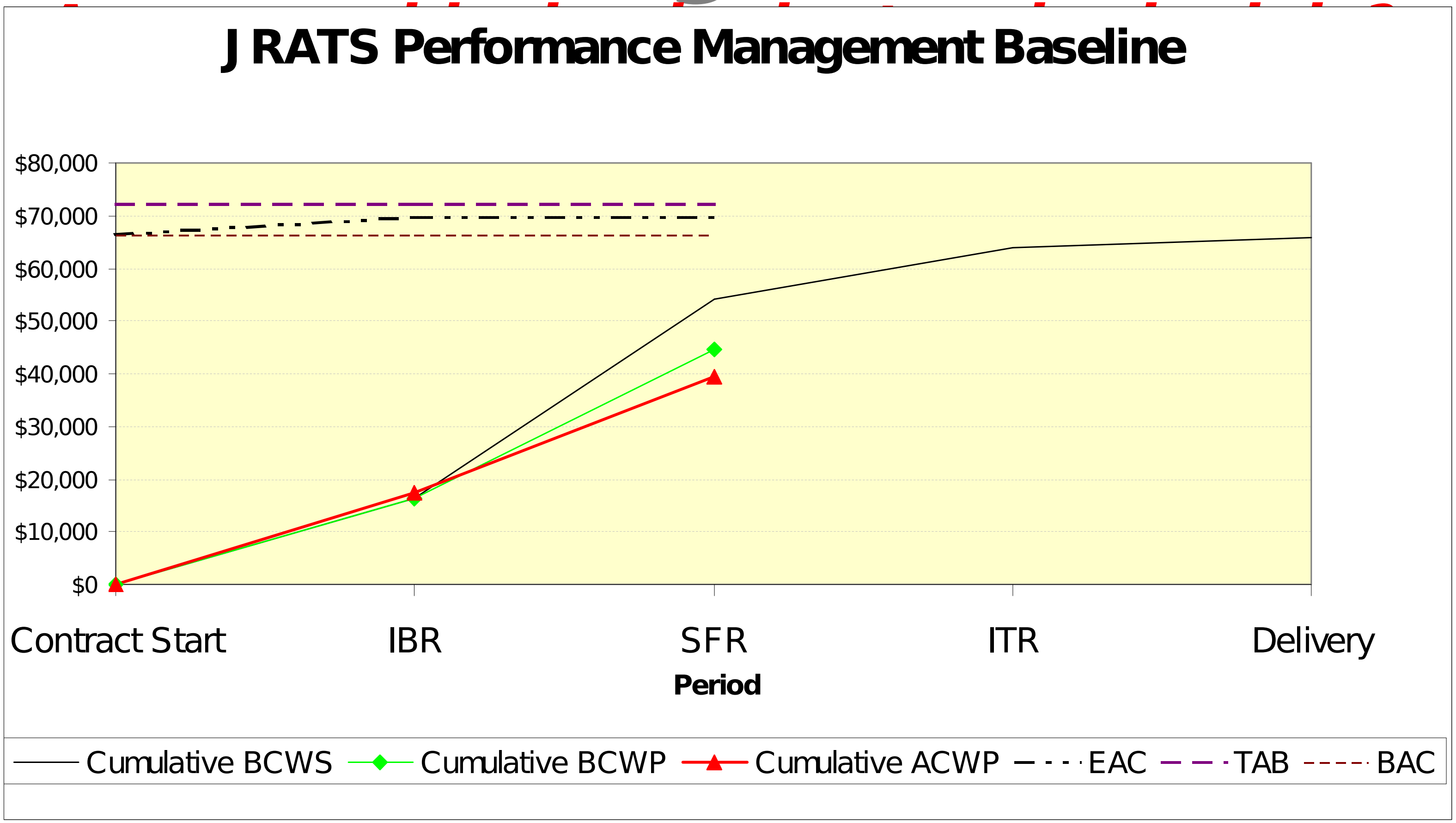


Technical Performance Measurements

Are you achieving performance on schedule?



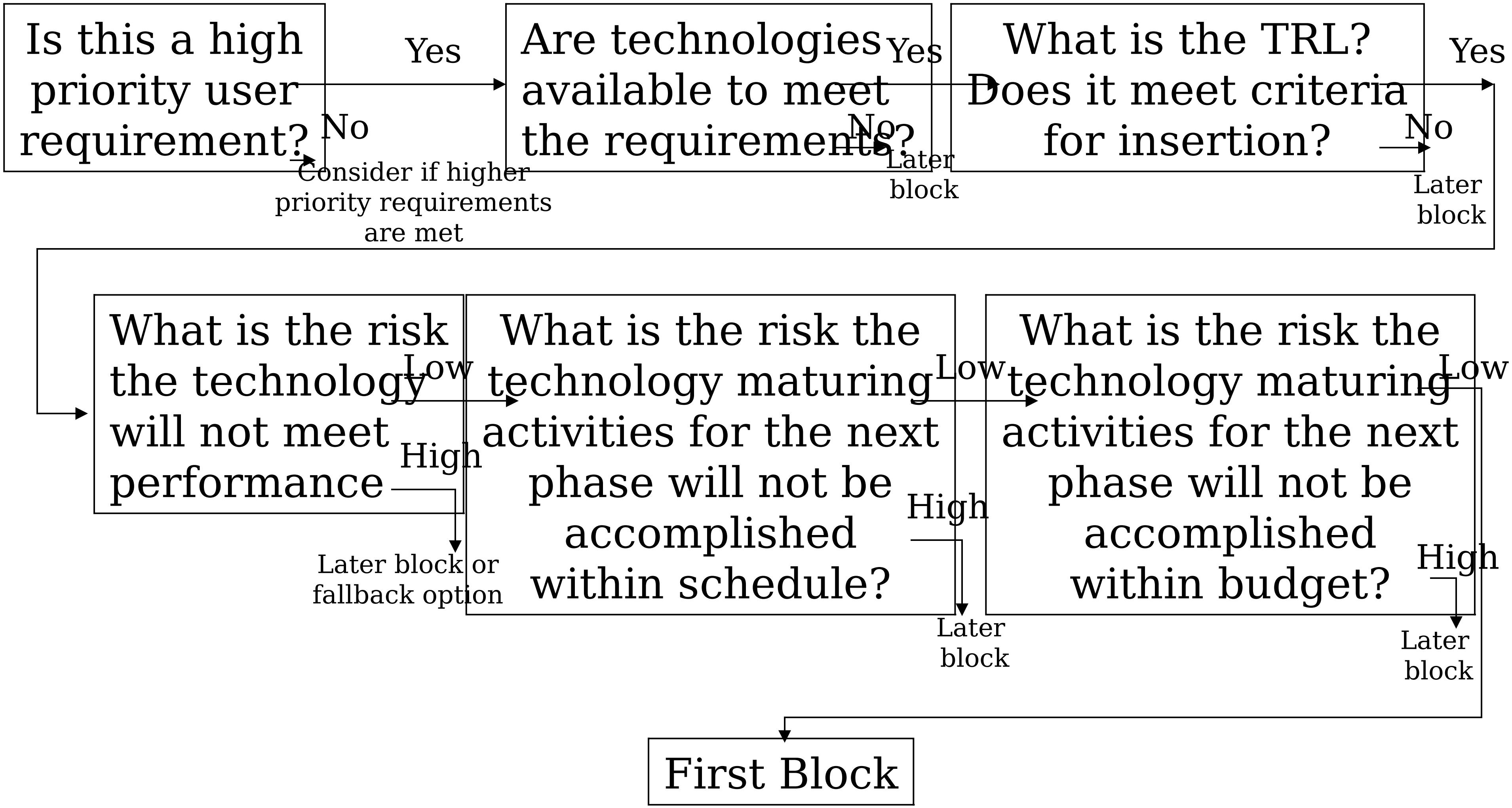
Earned Value Management



Cost Challenges

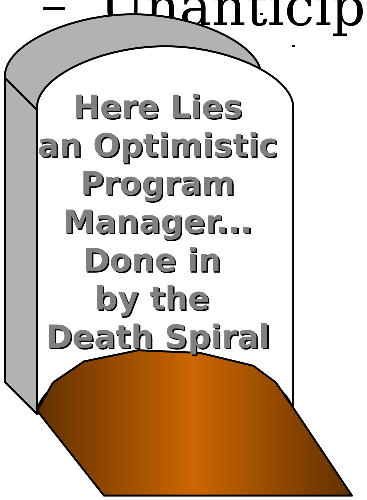
- Cost Estimation
  - Difficult to estimate the cost when requirements and technologies are evolving
  - How much will the full capability cost?
  - Color of money
    - Parts of the system may be in development, production, operations and support simultaneously
- Funding stability
  - Commitment to follow-on blocks
- Full funding policy

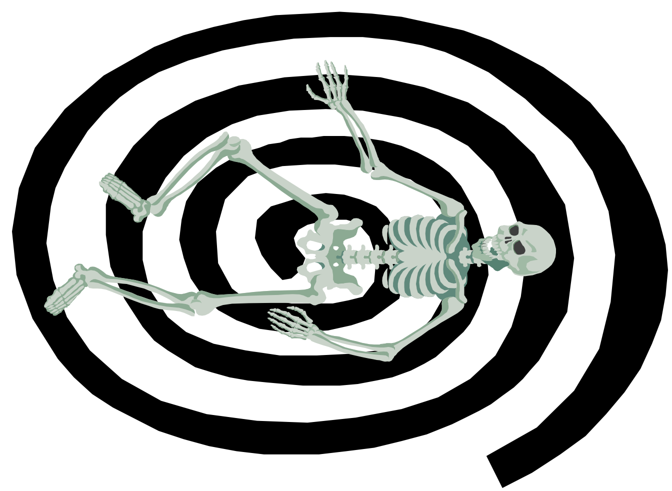
Building an Evolutionary Strategy



Avoid "The Death Spiral"

- A cascading deferral of planned functionality
- Occurs when insufficient accommodation is made for unplanned growth in development effort
- Three basic causes
  - Unanticipated requirements growth
  - Unanticipated support cost growth for early increments
  - Unanticipated implementation challenges





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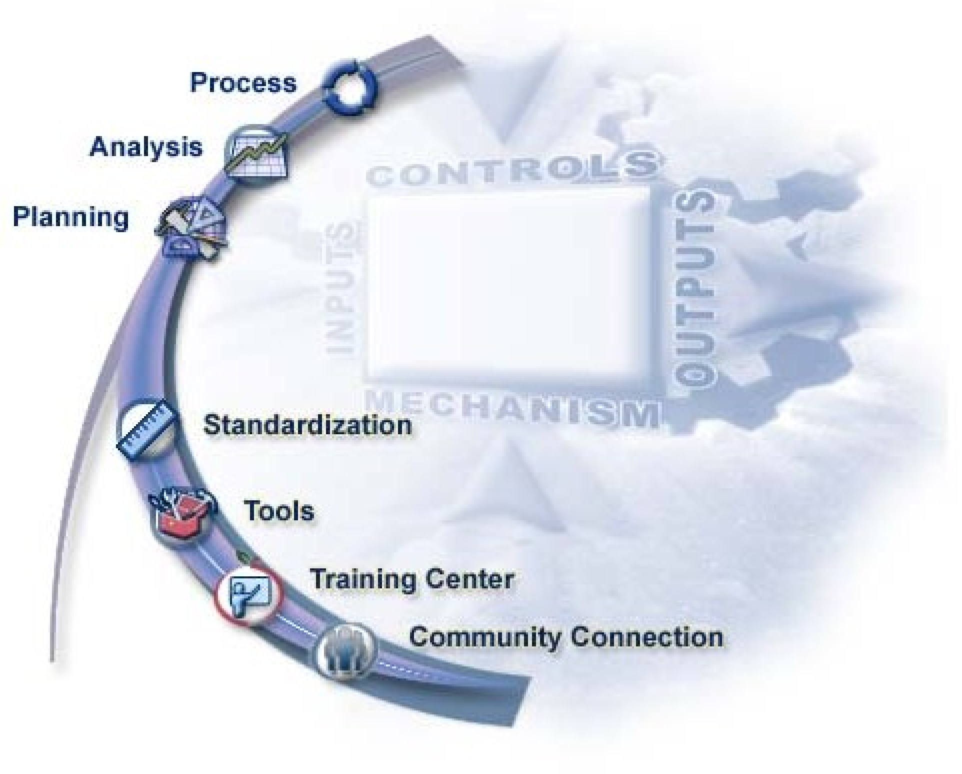

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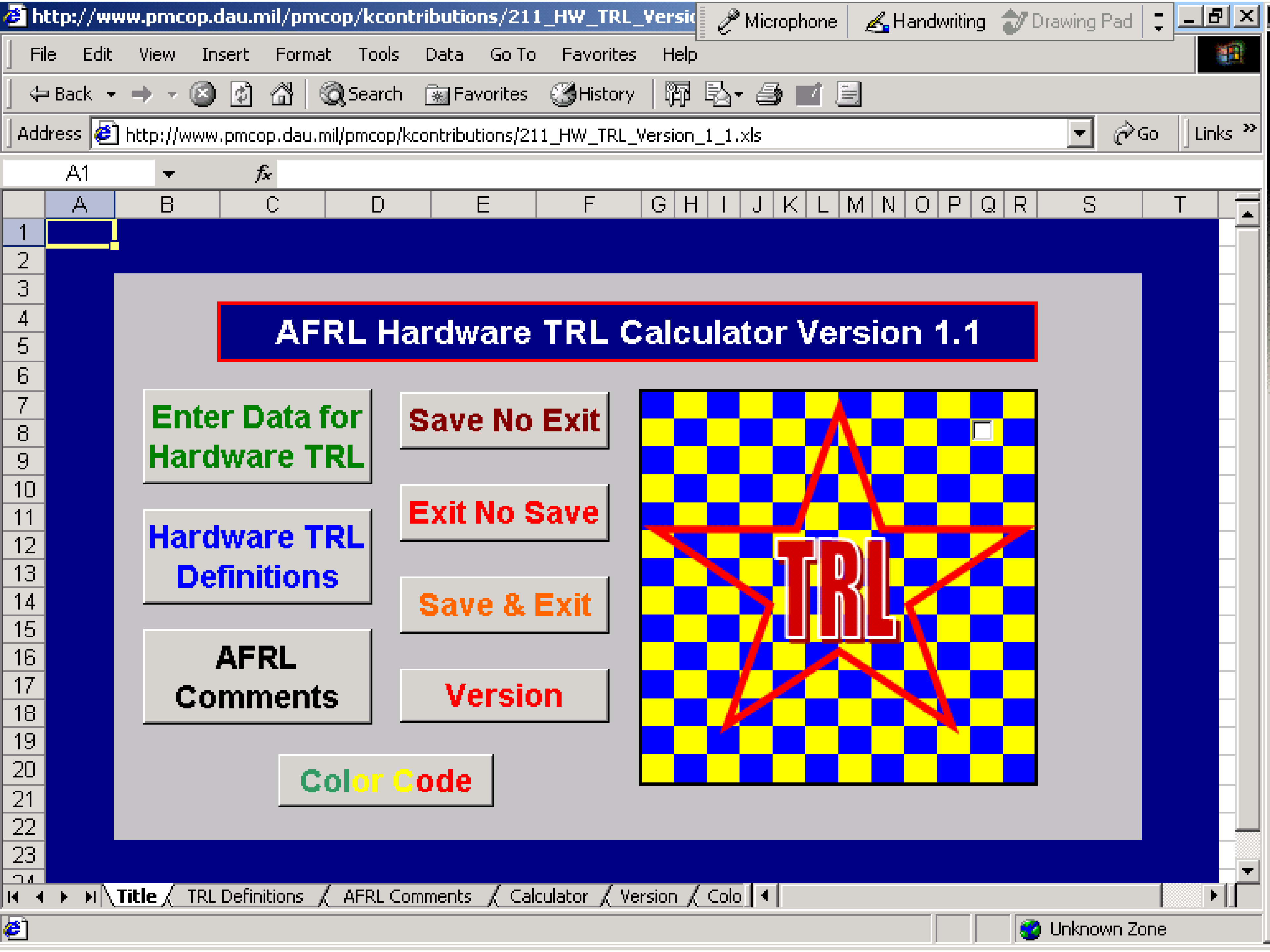
Features

- New! Science and Technology Management Career Field
- Probability/Consequence Software (P_CS)

NASA Systems Engineering Seminar Series

What's New

- New Version of P_CS Software Tool is now Available
- Evolutionary Acquisition Template [draft] [R-TOC Working Group]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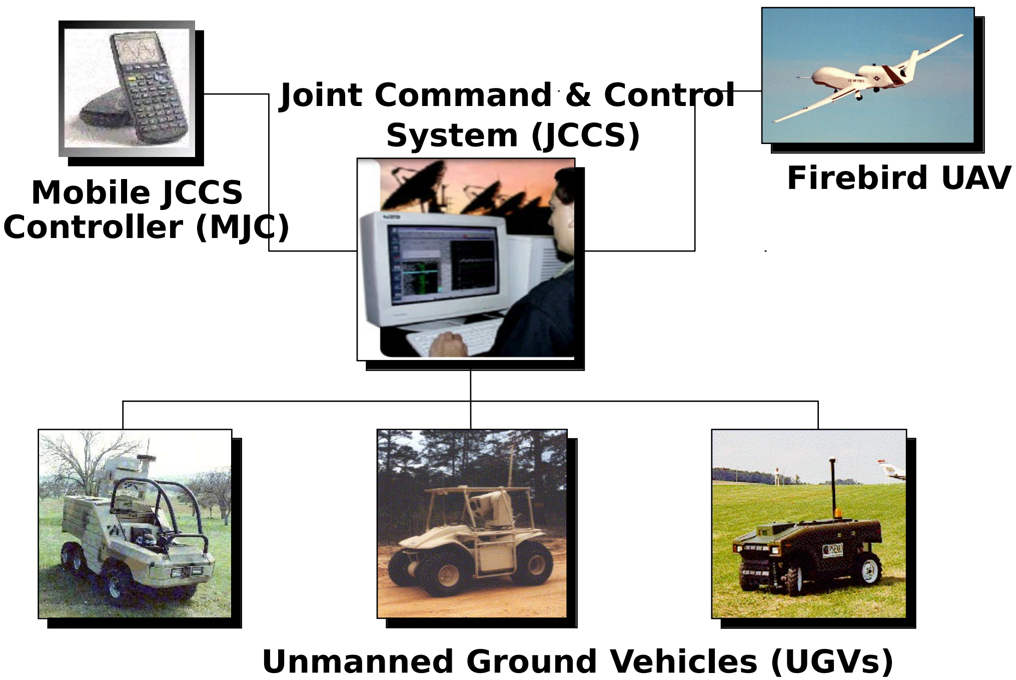
Evolutionary Acquisition Summary

- Delivers initial capability to the user in a shorter time period
- Improves technology available to the user in the final product
- Reduces the risk of embarking on an unexecutable development plan
  - Allows earlier cancellation if problems arise
- But, is not likely to be cheaper
- And, will likely take longer to reach the final capability

Joint Reconnaissance and Autonomous Targeting System



- Future based program
- Choose from existing UGVs
- Arm for attack mission
- Technology insertion into existing systems

Joint Reconnaissance and Autonomous Targeting System

- Interoperable with UAV and

Exercise

- Given the MNS, Draft ORD, and technology reports develop a spiral development strategy that can accommodate all three candidate vehicles
  - Use a 24 month System Development and Demonstration Period beginning Second Quarter of FY06
    - What are the recommended Block I and Block II capabilities?
  - If Block II development concludes not later than the end of FY 10
    - When does Block II development have to begin?

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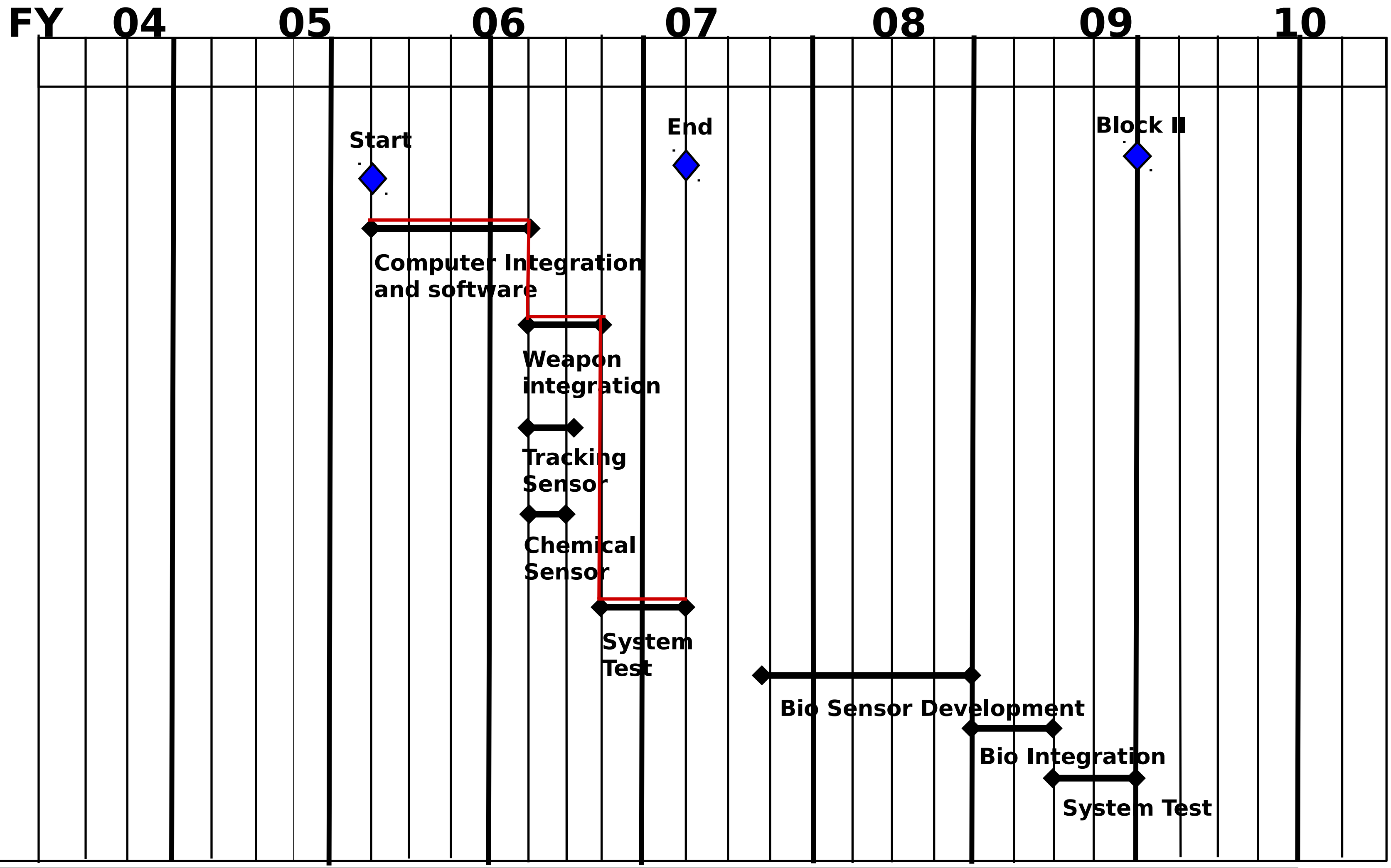
JRATS Program Structure



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O&M	0	0	0	0	0	0	0	0	0
Personnel	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0